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SOME OF THE WAYS IN WHICH ANIMALS BREATHE.*

By Professor F. Jeffrey Bell, M.A.

If we consider the essential points, as distinguished from the special or accessory methods, of human respiration, we shall most easily get at the central and important facts. Minute by minute we take into our lungs a certain quantity of what we call air, and as often we get rid of what we call air too. But between what we *inspire* or take in, and what we *expire* or give out, there are certain differences; differences which, not detectable on a breezy common, soon become unpleasantly obvious in an ill-ventilated or overcrowded room. In other words, we get rid of something which we had best not take in again; that something you know is the gas which is called carbonic acid; and, though carbonic acid is quite in its place, and indeed very pleasant, in seltzer-water or champagne, it is not to be recommended as a "respiratory medium"; a little too much of it produces headache and malaise, still more of it (as in suicides by charcoal poisoning) produces death.

Air, as you know, is chiefly composed of oxygen and nitrogen, and, speaking generally, there are 21 parts of the former to 79 of the latter gas in every 100 parts of atmospheric air; if you breathe pure oxygen you become exhilarated, and if you take it

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too long your respiratory movements will cease. If, on the other hand, you diminish the supply of oxygen, you will become "asphyxiated." What you want, then, is oxygen, but you want this diluted.

The first point, then, to which you must hold is this; you cannot continue to live without fresh supplies of oxygen. What is true of you is true of every living thing, whether animal or plant, that is made up of protoplasm. Supposing these supplies to be present, how are they used? They are used up, we know, because after a time the air of a space, into which fresh oxygen cannot enter, becomes unfit for respiratory purposes. They are, so far as we can judge from the condition of the air, used up in making carbonic acid; in other words, inspired air contains more oxygen and less carbonic acid than does expired air. The proportions per hundred parts being—

	Oxygen.	Nitrogen.	Carbonic Acid.
In inspired air	20·81	79·15	·04
In expired air.........	16·033	79·557	4·380

So that about 4 per cent. of oxygen is lost from the air in the process of breathing.

But now arises this question: If every living thing requires oxygen, your great toe no less than your brain requires at times a fresh supply—how does it get it? It gets it from that medium which is the source of communication between the various parts of the body—it gets it from the blood. If you were to take some blood which had just been pumped out of the heart into the great blood-vessels, and compare it with an equal quantity of blood just returned from the body to the heart, you would see that the former would be bright scarlet, the latter of a purplish hue; and if, with a suitable air-pump, you removed the gases from the blood, you would find that the amount of oxygen in the purple blood was only one-half of that in the scarlet fluid, and that the carbonic acid had increased by about eight parts in a hundred; and further, were you to shake up the purple blood with air or with oxygen you would find it become again of a bright scarlet colour.

The second point, then, is this: on its way round the body the blood loses its oxygen and gains carbonic acid. Though we call this blood a fluid, yet it is, we know, "thicker than water";

it is thicker because it is not merely watery,—it has suspended in it a number of little bodies which are called "corpuscles." Of these corpuscles some are white, and some are what we call red, though in a shallow layer they are rather yellowish in colour; but in mass they are red. The redness of the blood is, of course, due to the redness of the red corpuscles; the redder they are the redder the blood.

Note here, then, that the process of respiration appears to have as an accessory phenomenon a change in colour; and observe that this colour is dependent for its change on the addition or removal of oxygen. The colouring matter of the red blood corpuscles, which may exist in two stages of oxidation, one a higher and the other a lower, is surely enough the body to which we must direct our attention if we want to find out the secrets of our respiratory processes. The matter itself is known as *hæmoglobin*, and chemical investigation has shown that more than 90 per cent. of dried red blood corpuscles consists of hæmoglobin. This hæmoglobin may be separated from the blood corpuscles, and, after suitable treatment, appears in the form of crystals; the crystals are soluble in water, and it is possible therefore to have a solution of hæmoglobin.

In 1862, Prof. Stokes, now President of the Royal Society, applied to blood that instrument which has done so much in revealing to us the composition of complex bodies; you know, of course, that if we examine solar light by means of the spectroscope we find the various bands of colour, red at one end and purple at the other, marked by dark bars; and that these dark bars, which have been accurately mapped out, reveal the presence of certain elements in the light; the so-called D lines are, for example, the only two that are seen when pure sodium is being burnt before a spectroscope. The investigation of colouring matters by Sir David Brewster, Sir John Herschel, and other philosophers showed that some of these matters when examined by the spectroscope present dark bands or bands of absorption of light; these are the so-called absorption-bands. Now, Prof. Stokes found that arterial and venous blood gave different absorption-bands, and that by adding reagents which reduced the blood or took up its oxygen he could convert the two bands of any hæmoglobin into the single intermediate band of reduced or venous hæmoglobin.

This power of carrying oxygen may be made clearer to you if I remind you that the same property is possessed by nitric oxide, and is made use of in the manufacture of sulphuric acid, Sulphurous acid (SO^2) acting on nitrous acid in the presence of steam forms sulphuric acid and nitric oxide. The nitric oxide, if put in contact with moist air, takes up oxygen from it, and forms again nitrous acid.* In this way a small quantity of nitric oxide helps to make a large quantity of sulphuric acid.

If I put this shortly, I shall put it in the way I particularly wish you to remember to-day. Hæmoglobin exists in two states of oxidation. If this be true of hæmoglobin it is, no doubt, true of other colouring matters, which with similar tests give different absorption-bands; and, if this be true, then is the converse true also. Colouring matters which exist in two different states of oxidation are respiratory agents. Before, however, we pass to the consideration of other colouring matters, let us first review our knowledge of hæmoglobin.

Aristotle's division of animals into those with and those without blood has long since ceased to recommend itself to naturalists, but until 1872 they were altogether ignorant of the distribution of hæmoglobin outside the division which is called that of Vertebrates, and to which alone Aristotle assigned the possession of blood. In that year Prof. Ray Lankester gave an account of his researches, which had extended over more than four years, on the distribution of hæmoglobin in Invertebrates; additions of various forms have since been made, but only one important addition, that of a representative of a different subkingdom. Lankester found the colouring matter in various marine and fresh-water worms, in molluscs, and one larval insect; in 1880 M. Foettinger reported its presence among the Echinodermata, for he found it in the water-vascular system of the Ophiurid, *Ophiactis virens*; lately Mr. W. H. Howell has found it in red discs in the water-vascular system and the body-cavity of a Holothurian. In all but a few of these cases (*Solen*, *Arca*, *Glycera*, *Capitella*, *Phoronis*, *Thalassema*, *Hamingia*) the hæmoglobin is not contained in special corpuscles as it is in ourselves and other Vertebrates, but it is dissolved in the fluid blood-plasma.†

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* $SO^2 + N^2O^3 + H^2O = H^2SO^4 + 2NO$. $2NO + O = N^2O^3$.

† The student interested in the subject will find a list of the animals in which hæmoglobin has been found in Dr. W. D. Halliburton's interesting

This useful oxygen-carrying colouring matter is not, however, confined to the blood; like some others which we shall have to notice soon, it is to be found in some of the tissues; it was detected by Lankester in the muscles of the vertebrate heart, in the voluntary muscles of mammals, in the muscles which move the "tongue" (odontophor) of Gastropod Molluscs, and in the central nervous system of the Sea Mouse (*Aphrodite aculeata*).

An account of its distribution in the nervous tissue of some of the Nemertine Worms has been given by Prof. Hubrecht, and its relations to the respiratory processes are here so obvious and so instructive that we shall do well to consider the question in detail. When I had the honour of addressing you last year I directed your attention to certain peculiarities in the structure of the Nemertine Worms, which exhibited a wonderful resemblance to what was seen in the Vertebrates; I told you then of the sacs or grooves which lay on either side of the head, and had the function of respiratory passages; these passages appear to be specially useful in carrying oxygen to the central brain-mass, or, in other words, they appear to act as parts of a cerebral respiratory apparatus. Now, in the division of the Schizonemertini, in which there is a deep lateral fissure on either side of the head, the nervous tissue is impregnated with hæmoglobin, but the blood is free of it; in the Hoplonemertini, on the other hand, the blood becomes the chief oxygen-carrier, as is shown by its impregnation with hæmoglobin; the lateral fissures close up, and hæmoglobin disappears from the nerve-tissue. The Schizonemertine arrangement appears therefore to be a temporary expedient for attracting oxygen to the parts which need it most; with this structural arrangement it is instructive to correlate the mud-dwelling habits of the worms that possess it.

Let us turn now to other colouring matters than hæmoglobin. Within the last few years, and especially owing to the researches of Dr. MacMunn, who has demonstrated that the active practising physician can aid considerably in the advancement of natural knowledge, our acquaintance with colouring matters other than hæmoglobin has been very greatly increased.

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memoir on the blood of Crustacea (Journ. Physiol. vi. pp. 332—3). The statement in the text as to the presence of hæmoglobin in special corpuscles is more correct.

The first colouring matter which attracted much attention was that which is so widely distributed among plants—leaf-green or chlorophyll, as it is ordinarily called. You know that if a plant be kept in the dark its leaves lose their green colour, and you know also that when sunlight shines on green leaves under water little bubbles of gas continually rise to the surface; this gas is oxygen, and it is known that chlorophyll is capable of breaking up carbonic acid in sunlight, storing the carbon and setting free the oxygen.

In a few animals, the fresh-water sponge, the green *Hydra*, some Planarian worms, the protoplasm may be seen to contain chlorophyll-corpuscles; and in the last of these Mr. Geddes has, by direct experiment, shown that in sunlight oxygen is given off, so that in them, as in green plants, the colouring matter is a producer of oxygen. The advantage of this to the animal is obvious; not only can it take in such oxygen as is dissolved in the water, but it can manufacture oxygen around of and for itself. That such an arrangement is desirable is, curiously enough, shown by another set of facts; in some of the Protozoa, the Radiolarians, and in the Sea Anemones naturalists have very frequently detected the presence of what they called "yellow cells." These were at first regarded as parts of the animal; but when it was found that they did not die when their host died, and that they could migrate from one individual to another, it was concluded that they were parasites; and parasites, in a sense, they are. But, unlike such parasites as the tape-worm or the fluke, they give as well as take; their yellow colouring matter is capable of breaking up carbonic acid, and while these Algæ—for such they are—store up for themselves the carbon, they set free the oxygen of which the host takes its share. This beneficial mode of clubbing together is now known as "Symbiosis."

In some of the marine Annelids (*Sabella*, *Siphonostomum*, *Chloronema edwardsii*) the blood is of a green colour; this colouring matter has been called by Lankester "chlorocruorin," and it presents in its oxidised condition an absorption-band between the lines C and D, and another, fainter, between D and E; on reduction of the oxygen the spectrum has a single band which lies between C and D, but is somewhat fainter than the almost similarly-placed band of oxy-chlorocruorin. Just as with hæmoglobin, the reduced solution has only to be shaken up with air for the two bands characteristic of oxy-chlorocruorin to reappear.

The fact that the blood of some snails is blue has been known for nearly fifty years, and since 1817 various corroborating observations have been reported; it remained, however, for a Belgian observer, M. Frédéricq, to put our knowledge on a firm foundation. In 1878 he described the phenomena presented by the blood of the Octopus; he found it to be blue on exposure to air, but to lose its colour when boiled in the receiver of an air-pump, or when reduced by the passage through it of a current of carbonic acid or of sulphuretted hydrogen; so far it resembles hæmoglobin, to which also it is similar in being composed of a proteid body, and of another which contains a mineral; this mineral, however, is copper, and not, as with hæmoglobin, iron. Frédéricq reported that oxy-hæmocyanin has no absorption-bands, but Dr. Halliburton finds that with an oxidised solution the ends of the spectrum are cut off, while there is no such diminution of light with a reduced solution.

Hæmocyanin is not confined to *Octopus*; it has been found by Krukenberg in the blood of the *Sepia* and the Squid, of the ear-shell (*Haliotis*), *Murex* (the purple snail of the Romans), and other Gastropods; by the same physiologist in the Crayfish and the Crab, and other Crustacea; and by Frédéricq in the Lobster. Professor Ray Lankester, as he doubtless told in an earlier lecture of this course, found it both in *Limulus* and in the Scorpion.

With regard, then, to the mode of respiration which is comparable to our own storing up of oxygen in the red blood corpuscles, and giving it to the oxygen-carrier hæmoglobin to distribute through the body, we find that all normal Vertebrates (here, of course, the Lancelet is not included) do the same; so do two molluscs, five worms, and one holothurian. A number of worms, some molluscs, some Echinoderms, and two Crustacea are known to have hæmoglobin dissolved in their blood; others have instead a green or a blue colouring matter, which in all the essential particulars of a respiratory colouring matter resemble hæmoglobin. Four Crustacea have tetronerythrin in their blood, and some Lepidoptera have chlorophyll. Here we have colouring matters in the blood. Incidentally I have told you already that hæmoglobin is found in certain tissues, in the muscles of mammals and others, and in the nerve-tissue of *Aphrodite* and the Nemertines. We come now to the consideration of other colouring matters which are deposited in the living tissues other than or as well as the blood.

From the curious green-coloured Gephyrean worm, which is known as *Bonellia viridis*, and which, when adult, lives in hollow cavities in rocks where it cannot be bathed by water, a green colouring matter can be extracted; this colouring matter is called Bonellein, and it is found to be deposited in clusters of green granules in the skin of the animal's body; on adding a little acid to this green matter it becomes purple.

If you place a Rosy-feather Star (*Antedon rosacea*), or such a common Sea-urchin as *Strongylocentrotus lividus* in fresh water you will find that the water soon becomes of a reddish-brown colour; if you want a larger and better supply you had better put the echinoderm into alcohol, which dissolves out the colouring matter more completely and rapidly. This colouring matter, which has been closely studied by Dr. MacMunn, has been called by him Echinochrome; to his admirable papers I must refer you for details. Here only can it be said that he finds it capable of existing in two stages of oxidation, one higher and one lower; resembling hæmoglobin in this, it doubtless also resembles it in its function of being a respiratory agent.

The very beautiful colouring matter of the stalked Crinoids, to which Prof. Moseley has given the name of Pentacrinin, has not only different absorption-bands, according as its solution is acid or alkaline, but an acid solution is red and an alkaline one green.

In a large number of invertebrate animals, Dr. MacMunn has discovered a body which is allied to chlorophyll; as it is deposited in the glands connected with the intestine (enteron) he has called it Entero-chlorophyll. This substance appears to be formed by the animal itself in the glands which, far from correctly, are spoken of as the "liver" of the Starfish, the Crayfish, or the Oyster. On this, as on two other colouring matters which have been found by the same observer in the tissues of both Vertebrates and Invertebrates, *viz.*, myohæmatin, which is found in muscular tissue, and histohæmatin, we may hope to have soon much further information. For us the great point is that they are all respiratory in function.

The red coloration of the body of many marine animals appear to be associated with yet another colouring matter of respiratory significance; to this Wurm, who first observed it in those red parts on the beaks of Pheasants and other birds, which ornithologists call the "rosette," gave the name of tetronerythrin; Merejkowsky has found it in 104 species of Invertebrates and fishes, and he tells us that it is often present even when the animals appear to be yellow, green, or brown in colour; it is chiefly found in the tissues that come in contact with the water, and it is important to observe that it is absent from those forms which have symbiotic algæ providing them with oxygen. Dr. Halliburton has found it in the blood of Crustacea. The function of this colouring matter is quite possibly respiratory, but, as it does not lose and take up oxygen, it cannot be compared with hæmoglobin or hæmocyanin.

We have now to consider the ways in which the oxygen in the air or in the water makes its way to the tissues, or to special organs set apart for respiratory purposes; these ways may be conveniently grouped under three heads:—

1. The simplest and the earliest arrangement is that which has been called vague. Here there are no special respiratory organs, and in the simplest cases even respiratory colouring matters are wanting. The simple *Amœba*, and the Protozoa generally, the lower worms, such as Planarians and others, afford us examples of forms in which the whole body, being bathed in water (or rarely in air), the carbonic acid of the cell or cells makes exchange for oxygen on the general surface of the body; in the Starfish, where respiratory pigments appear to be present, the thin membrane which lines the body cavity sends out a number of delicate processes between the interstices of the body-wall; these multiply the opportunities for gaseous exchange between the fluid within and the sea-water without the membrane, and so carbonic acid constantly escapes and oxygen as constantly enters.

In the earthworm, again, respiration takes place over the whole surface of the body, but the blood-vessels come very near to the surface; in the leech the general arrangements are much the same, save that the blood-vessels are still more superficial.

Here the cells of the epithelial layer underlying the structureless cuticle which they form is, as Prof. Ray Lankester has shown, penetrated by fine blood-vessels, which form an intra-epithelial system, and come as near to the surface as they possibly can. More recently M. Stolc has described an elaborate system of plexuses in the integument of an earthworm, *Ilyodrilus*, and a system of superficial capillaries has been found in the earthworms *Perichæta* and *Perionyx* by our prosector, Mr. Beddard. As our knowledge of the finer anatomy of lower forms increases we shall, I believe, be able to add considerably to the list of animals which, with a vague respiration, have their oxygenating blood-vessels brought into the closest possible relation with the external medium.

The greater number of definite respiratory organs fall under the head of outpushings or ingrowths; the former are called gills, the latter air-tubes (tracheæ) or lungs.

2. The system of respiration by gills is preceded physiologically by the method adopted by the Starfish; when carried further and made a definite arrangement, it often consists in the possession of a number of delicate tubes, hollow within, and having thin walls; within flows the respiratory blood or fluid, without is the external respiratory medium, the movement of which is often aided by the presence of those delicate protoplasmic processes which we call cilia; the constant contraction of these gives rise to the formation of currents in the water, and so allows of a renewal of the oxygen-carrying water. Delicate respiratory filaments of this kind are to be found among some of the bivalved Mollusca, such as the Sea-mussel (*Mytilus*), or the Scollop (*Pecten*); but they become converted into continuous plates in the fresh-water Mussel (*Unio*), and a large number of Mollusca. Here the motive power of the respiratory medium is to be found in the cilia which cover the gill-filaments or the plates into which they fuse. In the Crayfish, where the gills form plumes on either side of the body, the cells of which they are made up are, like all other cells in the bodies of Crustacea, quite devoid of cilia; the motive-power must consequently be looked for elsewhere. First of all we may find it in the fact that some of the gills are attached to the bases of the walking limbs, and it is clear that when these limbs move the gills will move too, and so agitate the water that bathes them; but even when

a Crayfish is at rest it requires fresh supplies of oxygenated water. To obtain this it does what Crustacea nearly always do when they need a fresh organ; it makes use of one of its appendages (the second pair of maxillæ), part of which it converts into a scoop-shaped organ which, lying at the anterior end of the box in which the gills are placed, moves backwards and forwards about 200 times a minute, and by scooping out water at that end creates a vacuum which is filled by a rush of water into the hinder end of the box.

A very interesting series of modifications are found among the Echinodermata; while the Starfish, in which the skeleton is often loosely reticulated, has no special respiratory organs, the Brittlestar, which has a closely-compacted skeleton, has a pair of clefts at the base of each of the five arms; these clefts lead into pouches or bursæ, the walls of which are thin and project into the body-cavity; into these pouches water enters and again escapes, taking in with it a fresh supply of oxygen, and bringing away with it carbonic acid. Among the regular Sea-urchins the gills are ordinarily external, and in the dry test their position may be noted by the notches or indentations around the margin of the mouth of the test. In the most ancient extant forms—the *Cidaridæ*—the gills are not external, but, as Prof. Charles Stewart has shown, there are five internal gills around the Lantern of Aristotle; here the water of respiration enters within the boundary of the test in much the same way as it does in Ophiurids.

3. Another set of breathing-organs obtains among animals that live on land, and in a comparatively small number of marine forms. Here, in place of projections outwards, there are depressions inwards, or in some other way cavities are formed into which air passes to meet perhaps with the blood which is richly distributed in the walls of the cavity. The best-known apparatus is that of lungs; as we know them in ourselves and all higher Vertebrates, such as other mammals, birds, and reptiles, these lungs are outgrowths from the anterior part of the digestive tract. It must not, however, be thought that this lung-cavity is confined to the higher Vertebrates; a sacular outgrowth from the intestinal tract is seen in a number of fishes; in some, as for example the Salmon, the air-sac, as the organ is then called, remains connected throughout life with

the tract; but in others, as the Cod, it becomes shut off from it, and forms a closed bladder. This air-bladder has in such Physoklistous Fishes merely the function of a hydrostatic organ; it diminishes the specific gravity of the fish, and aids it in supporting itself in the water. In ourselves the lungs are not often called upon to perform this hydrostatic function, but we find them useful when we try to swim, and without them we should indubitably sink to the bottom whenever we fall into water beyond our depth. In the Salmon the respiratory action of the air-bladder is no doubt unimportant; this for two reasons: it is not specially well provided with blood-vessels, and the Salmon is not in the habit of swallowing air by its mouth.

What is true of the Salmon is not, however, true of all fishes; some have the walls of their air-bladder specially well provided with blood-vessels, and some do swallow air by the mouth. The American Ganoid-fish, *Amia*, has been closely watched by Prof. Burt G. Wilder, who observed a captive specimen rise to the surface of the water in which it was swimming, open its jaws widely, and apparently gulp in a large volume of air. In such fishes as the *Ceratodus* of Australia, the *Polypterus* of West Africa, and the *Lepidosiren* of South America, which are the representatives of the group which ichthyologists call Dipnoi, or double-breathers, a special vessel is sent to the air-sac. This vessel, curiously enough, comes direct from the gills, branches in the wall of the sac, and then makes its way back to the heart to have its contents pumped through the body; such blood is, then, doubly aërated.

Interesting as these stages are, the gradations between air-sacs and lungs have not been exhausted; in the Salmon the duct of the sac opens on the upper or dorsal side of the digestive tract, in *Ceratodus* it lies to the left of the ventral surface; while in *Polypterus*, as in higher forms, it opens on the ventral middle line. In the Ganoid, *Amia*, the sac is single; in its ally, *Lepidosteus* (the Gar-pike), it is single externally, but divided internally; and in *Polypterus* it is double. Nor is the name sac, as indicating a merely hollow bag, any longer appropriate. Even in the first-mentioned Ganoids the cavity within is broken up by bands of intercrossing tissue, which support blood-vessels; the sac, in fine, becomes spongy in texture, and is, indeed, more spongy than in some Amphibians (e. g., *Menobranchus*).

While there are fishes that breathe by lungs as well as by gills, so are there some allies of the frog, which, unlike it, retain their gills throughout life; here, again, we get an instructive series of gradations. The lowest Amphibia, or those which retain their tail throughout life (Urodela), may, like *Menobranchus* and *Proteus*, have persistent gills in addition to lungs; in *Menopoma*, *Amphiuma*, and *Megalobatrachus* the gills disappear, but one or two of the clefts through which, in larval life, the gills protruded, persist in the adult condition, though the gills themselves are lost.

It is very instructive to remark with what difficulty the gills are lost; this is especially well illustrated by the developmental history of *Epicrium glutinosum*, the Cæcilian of Ceylon. *Epicrium*, as Messrs. P. B. and C. F. Sarasin have lately told us, lays eggs within which the young are hatched. While still within the shell the young develop, on either side of the head, a tuft of three blood-red gills which move about constantly in the surrounding fluid. When these gills disappear the young escape from the egg-shell and pass into water; here the gill-clefts are at first open, just as they are in the adult *Menopoma*; later on the clefts disappear, and the Cæcilian takes to a terrestrial mode of life.

As I am confining myself to breathing-organs, I must not now trace the fate of the gill-clefts in those higher Vertebrates in which gills never serve as organs of respiration; but you who have heard Professor Parker speak from this place know, doubtless, of the important functions which remain for the clefts, and the indications of them that are to be seen even in ourselves.

Quite another form of terrestrial respiratory apparatus is found in that great group, the members of which outnumber all the rest of the Animal Kingdom; I speak, of course, of insects and their allies. Here we have to do with thin tubes instead of with wide sacs; these tubes are called tracheæ, and the mode of respiration is not pulmonary but tracheal. The simplest condition of this mode is found in that most interesting and instructive animal *Peripatus*; this instructive creature shows by its wide geographical distribution that it is an exceedingly archaic form, and we might well suppose from that one indication alone (although, indeed, there are others in plenty) that we should find in it a very primitive condition of the respiratory apparatus. Scattered over the whole of the body there are minute orifices; these each lead into a pit which widens out at its base; from this base there are given off a number of delicate tubes which make their way into the organs of the body; it is by their means that the necessary oxygen is conveyed to the tissues and cells of the organism.

As we pass from this low and primitive form to the more highly organised Insects we find, as elsewhere in the Animal Kingdom, and as with other organs, that diffuseness and simplicity give place to concentration and complexity. The number of orifices becomes greatly reduced, so that at last there are but two or three pairs; the tubes themselves become strengthened and kept open by a chitinous fibre which extends spirally along them, and the supply of air to the whole body is effected by the branching of the trunks and their union with one another.

If I were to try to sum up what I have attempted to tell you to-day I should put the result thus:—

Respiration, or the exchange of fresh oxygen for the carbonic acid which is constantly formed as one of the waste products of the activity of all living cells, is to be observed in every living organism; like every other function, it is performed in a vague manner—or without the aid of special organs—by the lowest. In the higher there are special parts of the body allotted for this function, and these may be outgrowths or ingrowths. These organs are, in a large number of cases, aided by certain chemical compounds which have the office of oxygen-carriers; that is to say, they are capable of storing up oxygen and of giving it up again, and they are able to repeat this alternation of conditions repeatedly, and throughout life. Indeed, without them the life of the higher organisms would be impossible.

NATURAL HISTORY AND SPORT IN THE HIMALAYAS.

By Surgeon-General L. C. Stewart, F.Z.S.

(Continued from p. 294).

Fagoo, Oct. 3rd. — As I found other visitors were expected to-night, and Capt. H.'s accommodation was limited (his hospitality being in the inverse ratio), I deemed it expedient to start my small establishment directly after breakfast for Fagoo, about four miles on, promising to give H. a day of my society on my return. There is a decent travellers' or dawk bungalow at this place. The road is good, and the scenery lovely and varied *en route;* beautiful hanging woods, oak, rhododendron, yew, juniper, chestnut, and a score of others, looking their best in the autumnal change of leaf. Occasionally at an abrupt turn of the road a stupendous precipice would present itself, a corresponding wall towering above the road, which is in fact cut out of the mountain-face. At one of these points I came upon a colony of the Spine-tailed Swift, *Acanthylis* (or *Chætura*) *gigantea*, a bird of great interest, rare, and difficult to procure, from its amazing velocity of flight; requiring some skill in shooting, and a good deal of luck in recovering when shot, owing to the difficult style of country one has generally to traverse in searching for it. Luckily for me, on this occasion several of these Swifts were flying across the face of the cliff above me, and as I only fired when they were on the turn I thus minimised the chance of missing. I blazed away, and by good luck *bagged* three out of five I *dropped*, and that out of a dozen I *fired at.* All the time I thought it was *Cypselus melba* I was firing at, for I had never before seen the Spine-tail alive. My delight may therefore be imagined on procuring three specimens with such comparative facility. Nothing ever witnessed by me in the way of bird-flight approaches this Swift's rush; the nearest thing I could think of being the swoop of a Falcon (for I never saw a Humming-bird alive). I got three more to add to my collection before the trip was over. The acquisition of these birds took me an hour and more, but I did not consider it time wasted.

Sauntering along through the lovely woods I got among other things a pair of *Garrulax variegatus*, and I saw *G. leucolophus* and *G. albogularis*, besides *Geocichla citrina*, *Oreocincla dauma*, and a large speckled Thrush, presumably *T. viscivorus;* of *Ruticilla frontalis* a pair; *Henicurus maculatus* of course near water: this is one of the most beautiful and conspicuous of Himalayan birds. I knocked over a bird without knowing what it was; it proved to be a young one in very mottled plumage of *Petrophila erythrogastra,* so I fancy this Thrush is a late breeder. It is pretty common on the lower ranges, but not so conspicuous a bird as *P. cinchlorhyncha,* which delights to "pour forth" its rather pleasing ditty from the topmost branch of a tree; and why these two birds are called "Rock Thrushes" I know not, for they are essentially sylvan in their habits. Just as I reached the Fagoo Bungalow, I got a specimen of *Zoothera monticola,* an odd-looking, ungainly bird for a Thrush, if Thrush it be; the first example of it I secured the previous winter below Kussowlie at first puzzled me; I thought the strangely long bill was an individual deformity.

Oosrao had been successful in the forest again, and brought in a brace of Kalij Pheasants and a splendid Eagle, *Spizaetus Nipalensis,* an adult male. These Eagles are, in my poor judgment, a good deal mixed up in books, but this bird answers to Jerdon's description pretty well; a series of specimens and works of reference are, however, essential for the determination of species whereof individuals are found to differ according to age, sex, and sometimes season of the year.

My friend Capt. T. rode up to the door just in time to share my dinner, and he would have had short commons had I not ordered one of the Kalij Pheasants to be spatchcocked; and we resorted to the same excellent mode of cooking them on many other occasions. As we were sitting down to dinner I saw a large Owl glide past the verandah and settle on an oak behind the bungalow; my gun was dismantled at the time, having just been washed out; on putting it together I cautiously crept out, and after much dodging knocked the bird off its perch; but unfortunately a shot had carried away a portion of its bill. I sent this specimen to Calcutta, labelling it *S. aluco;* but Blyth in acknowledging it informed me it differed from that species, and called it *S. nivicolum* of Hodgson. I afterwards had an opportunity of comparing this specimen with examples of the European bird in the Asiatic Society's Museum, and confess I did not then see sufficient grounds for separating them. In after years I got several examples at Landour, and kept one alive for many months, feeding him, when I had the chance, on *Mus niviventer*, the common house Rat of the hills. In an adjoining cage I had a specimen of the beautiful *S. newarense*, which had been sent to me from the interior by my friend Mr. Frederick Wilson ("Mountaineer"), and I had many a visitor to see these pets. I got two kinds of Horned Owl in these mountains, viz., *Bubo Bengalensis*, which is rare off the plains, and *Ketupa flavipes*, the Yellow-legged Fish-Owl, also a rare species; its congener, *K. Ceylonensis*, pervades India, Ceylon, and Burmah, but I have not met with it on the hills.

Fagoo, Oct. 4th.—I had a very successful day, and might have obtained many more specimens, but, as it was, got more than enough for the stuffer to prepare properly. Starting at daylight, I strolled about for three hours in the beautiful "hanging" woods; many of the shrubs and trees were assuming their autumnal tints. Wild fruits and berries were in abundance; raspberry, barberry, and others affording ample food to hosts of birds of many kinds. I first secured a pair of Bullfinches, *Pyrrhula erythrocephala*, a pretty species which I had found at Kussowlie the previous spring, and I got three or four more before leaving Fagoo.

A second species, *P. aurantiaca*, has been described from Cashmere, and two or three others from Nipal and Sikim, at great elevations. In dense brushwood I noticed a pair of small brown birds hopping about, turning up the dry leaves and keeping up a faint whistling conversation. I did not at first recognise them, but on securing a specimen found it was the Red-eyed Wren Warbler, *Stachyris pyrrhops*. It is not a very common bird, but pervades the whole of the N.W. Himalayas. I afterwards found it to be very common at Koteghur, and I there observed it to be more arboreal in its habits than on this occasion, frequenting the mulberry-groves, &c. I once got its nest in the soldiers' garden at Kussowlie, in the end of May, in a thicket of dwarf bamboo; a shallow cup made up chiefly of fine grass-stalks, with a few leaves, on which lay the four eggs of a light greenish grey, with faint dark spots and speckles.

The Kalij Pheasant, *P. albocristatus*, is by far the most common kind in this part of the hills, and is found in winter at the foot of the first range. I shot a brace to-day; and they figured on our table almost daily during this expedition. They are constantly brought in for sale by the native poachers, and may be bought for three or four annas each (fourpence to sixpence); and I have found them most plentiful in low jungle, but not in the depth of the forest. They are usually met with in pairs, but I once put up a covey of more than a dozen. I esteem them the best of the hill Pheasants for the table. Following the course of a mountain-stream, I obtained fine specimens of several species restricted to such localities, the most conspicuous of these being of course the *Henicurus*, and the two Water Redstarts already noticed. Another irrepressible bird always to be met with about the mountain-torrents is *Myiophonus Temminckii*, the Himalayan Blue Whistling Thrush; in this species the bill is yellow, thus distinguishing it *inter alia* from its representative of Southern and Western India, whose bill is black. Of other Thrushes observed to-day I may mention *Oreocincla mollissima*, *Merula Wardii*, and *M. bulbul*, of which I got good examples; all of these were observed solitary. Of *M. castanea* I saw a party of eight or ten, and bagged a pair at a shot. I believe it is not decided among ornithologists if this bird be a distinct species from *M. albocincta*. The only Bulbul I noticed in this part of the country is *Pycnonotus leucogenys*, the white-cheeked, crested one, and it is very common; it leaves for the plains about this season, revisiting the hills to breed about April. A species of black Bulbul with red vent, *P. pygmæus*, visits the hills also in summer, and occurs at Kussowlie and Simla; but I have not seen it farther within the mountains, nor did I see the red-whiskered species, *P. jocosus*, at all.

I noticed a pair of dusky Mynahs, *Acridotheres fuscus*, this morning, and subsequently a few at Koteghur; but they are not nearly so common in these parts as about Mussoorie and Almorah, where they supplant the almost ubiquitous *A. tristis*. I saw no other kind of Mynah during the trip. Of Laughing Thrushes I this day noticed four species: *G. albigularis*, very common and self-asserting, in large families; *G. variegatus; G. erythrocephalus*, less so, and in smaller assemblages; and *G. lineatus*, always in pairs. Found a beautiful pendent nest, undoubtedly that of some species of *Nectarinia*, possibly *N. Gouldii*, or it may be *N. miles*, if that lovely species occurs so high. It was of the usual pyriform shape, constructed of thickly-felted materials, leaves, hair-like grass, &c., lined with thistle-down, and plastered outside with cobweb; and with scraps of tiny lichen, bits of decayed bark and wood, and two or three feathers here and there stuck on to set off the building; the entrance, an oval hole, was about half-way down; and there had been a shelf or portico over it, but the rain had somewhat disintegrated this portion of the beautiful little fabric.

I shot a fine Wood Pigeon, *C. Hodgsonii*, on my way home, and observed several of them, but very shy. Capt. T. had gone out on a different beat, but had brought in nothing particularly noteworthy; his best spoils being a *Zoothera monticola* and a Yellow-naped Woodpecker, *G. flavinucha*, a female, which has the front of the neck pale chestnut in place of yellow, as in the male. A Ghoral, which started within a few yards of him, got away safe, as he was loading at the time, and he saw no other game of any sort. A paharee brought in for sale this evening sundry skins of Pheasants, but they were useless as specimens, from want of adequate "antiseptic treatment," having only been rubbed over with solution of alum; but he had a good flat skin of the Pine Marten, *M. flavigula*, and a couple of the pretty Himalayan Weasel, *Mustela subhemachalana*, which I gladly purchased. The Weasel was new to my collection then, but I afterwards got several in the neighbourhood of Mussoorie. This man told me he had seen a pack of Wild Dogs the day before, and engaged to shoot one for me; but I saw no more of him nor of the dogs.

Fagoo, Oct. 5th. — We had a beat for game in the woods to-day, but our success was not brilliant, only five Kalij Pheasants after as many hours good hard toil. Capt. T. remained several hours longer, *solus*, and got another brace, and a Woodcock, a veritable *Scolopax rusticola*, an early arrival, and therefore unlooked for in the beginning of October. These woods seem designed for them, but I never saw a second from this part of the hills. North of Mussoorie they are not so rare, and from that locality I have also seen specimens of the Himalayan Solitary Snipe, *G. solitaria*, as I have of the Wood Snipe, *G. nemoricola*, from the country at the foot of the hills; but they are by no means common birds, any of them, and it is considered rather an event to bag one.

I got a single specimen of the curious little Piculet (as Jerdon calls it), *Picumnus innommatus*, in the afternoon. As its name implies, it is a dwarf Woodpecker, but much less arboreal in its habits than that family generally is, affecting brushwood and coppice, creeping about the low branches, and seeking its insect-food among the fallen twigs and leaves. It is not usually found at so high an elevation, but its small size and unobtrusive habits may lead to its being overlooked. One of the best birds I procured during the whole trip was, to-day, a single specimen of a minute Tit-like bird, *Ægithalus flammiceps*, which I had only seen once before, below Simla. There were several of them mixed up with a large family party of other small insectivores in a rhododendron, but they all dispersed before I could load again. They are in general not so easily put to flight. I met with it a few marches on, at the margin of the pine-forest, several times. As I had had enough of fagging for the day, and there were a good many specimens to prepare, I sent Oosrao out in the afternoon with my gun to explore the woods. He brought in after dusk a beautiful Wood Owl, *Syrnium Newarense*, obtained in a deep ravine close to the bungalow, and had seen another. This specimen measured 20½ in., and its alar expanse 52 in., and was in perfect plumage; irides dark brown; and the stomach contained a large bolus of feathers and finely-comminuted bones of a *Hypsipetes*, as far as I could make out. Oosrao also produced a Flying Squirrel, *P. inornatus*, and said he had killed its companion; but could not find it, owing to the density of the underwood. The only other trophy he brought in was a specimen of *Zoothera monticola*.

Fagoo, Oct. 6th.—Spent the whole of this day in the woods, and did not deem it necessary to go a mile beyond the bungalow. I got nothing new to my collection, but added some rather good things to it. Among these sundries were three fine Grosbeaks, *Coccothraustes icterioides*, and I noticed a dozen of them; *Megalaima virens; Pomatorhinus leucogaster*, the first seen of this species, and it was solitary; *Sibia capistrata*, common in the woods; *Siphia strophiata; Myiagra cærulea; Picus Macei;* and *Caprimulgus monticolus*. I might have got scores of specimens of sorts, but refrained from firing at anything I did not really particularly want. Capt. T. went off by himself in quest of game, and bagged a Cheere Pheasant and a Kalij, and a couple of Wood Pigeons, *C. Hodgsonii*. As he seemed rather anxious to push on, we resolved to make for the next bungalow in the morning.

Theog, Oct. 7th. — Elevation 7400 ft.; distance from Fagoo five miles and a half; a good road, and lovely scenery. Started after an early breakfast, and reached this place late in the afternoon, stopping here and there at likely places for ornithological gains. It was a delightful ramble, the weather perfect, and the scenery beautiful, beyond my poor powers of description. A good little staging bungalow here, though somewhat out of repair; the rains had been heavy, and the ceilings and walls bore signs of dilapidation therefrom. In course of the day I saw at least a dozen Lammergeyers, *Gypäetus;* they are easily distinguishable a long way off, which most of them were, by the peculiar wedge-shaped tail. The Great Himalayan Vulture, *Gyps fulvescens*, sails along in much the same majestic style, but is easily recognised by its square tail and the upturning of the tips of the wing-feathers. Somebody (I think Hutton) separates the Himalayan from the European Bearded Vulture. I have not seen the latter *wild*, but the captive examples in the Zoological Gardens, though adult, have not a trace of the ferruginous colour which pervades the whole under parts of the Himalayan bird when mature; and I think that, although two blacks do not make a white, distinct species have certainly been manufactured with less reason. The Briton in India always calls this bird the "Golden Eagle"; the native name for it here and at Mussoorie is *Eel*, which signifies Eagle. All Vultures are called *Geed*.

I got nothing new nor particularly interesting on the way home, but among other acquisitions may notice a Sparrowhawk, *A. nisus* undoubtedly, which in my experience is equally common with *A. badius* on these hills, where both species breed; *Merula Wardii; Oreocincla dauma* and *O. mollissima*, both beautifully soft-plumaged Thrushes; *Turdus viscivorus*, and another member of the same family, which I did not make out at the time, but which proved to be *Geocichla unicolor*, and was the only example procured in this outing. Subsequently I shot it in many wide-apart localities, the Western Ghats among others. Of this group of the Thrush family another is represented on these hills, *G. citrina;* but we did not meet with it, although it is common at a lower elevation; and a third, *G. cyanotus*, occurs in the Malabar forests, and is by no means scarce at Mahableshwur.

(To be continued.)

NOTES ON THE VERTEBRATE ANIMALS OF LEICESTERSHIRE.

By Montagu Browne, F.Z.S.
Curator, Town Museum, Leicester.

(Continued from p. 238.)

Order Limicolæ.—Family Œdicnemidæ.

Œdicnemus scolopax (S. G. Gmelin). Stone Curlew.—Formerly occurring in the county as a summer migrant, but much scarcer of late years. It has been met with in the parishes of Croxton, Kerriel, Saltby, and Waltham, on the south-eastern side of the county. The late Mr. Widdowson noted it as having bred annually some years ago at Stonesby Heath, but none have been observed there of late years.

Rev. R. Hart writes that "the Thick-kneed Plover still breeds on Ryhall Heath, Rutland."

Family Glareolidæ.

Glareola pratincola (Linn.). Collared Pratincole.—The only authority I have for including this bird in the present list is that contained in the MS. catalogue of the contents of the Museum when handed over to the Corporation on 19th June, 1849, wherein one is mentioned with the remark, "shot near Leicester."

Family Charadriidæ.

Cursorius gallicus (Gmelin). Cream-coloured Courser.—This rare bird is figured in Potter's 'History of Charnwood Forest,' from a specimen in the possession of the Rev. T. Gisborne, of Yoxall Lodge, Staffordshire, procured near Timberwood Hill, Charnwood Forest, in October, 1827. The same specimen has also been figured by Bewick and Selby. Anxious, if possible, to obtain some particulars of so rare a bird, Harley wrote to the late Mr. Gisborne, author of 'Walks in a Forest,' in whose possession it was known to be, and received the following reply:—"Yoxall Lodge, Needwood Forest, July 4, 1840. The example of *Cursorius isabellinus*, respecting which you inquire, was shot on Charnwood Forest, near Timberwood Hill, in October, 1827, by a tenant of my eldest son. The tenant met my son accidentally directly afterward, and showed and gave the bird to him as an unknown curiosity; and my son, who was on his way to this neighbourhood, brought it forward to me."

Charadrius pluvialis, Linn. Golden Plover.—A winter visitant, between October and March, not common, and chiefly confined to Charnwood Forest and the wild hills around. Occasionally, however, it is found on the meadow lands which fringe the River Soar. It has been noted at Coleorton, Smeeton, Gumley, and Foxton. Mr. Davenport saw a flock of about fifty on March 15th, 1883, and others have been met with in the Vale of Belvoir, in the Abbey Meadow, and in a field just off Saffron Lane, Aylestone, where sixty or more were counted in a flock. Mr. W. J. Horn saw some near Uppingham, Rutland, February 14th, 1886.

Ægialitis hiaticula (Linn). Ringed Plover; Ring Dotterel. —A rare summer visitant. It has, however, occurred several times in the Abbey Meadow as well as in the meadows at Belgrave, and I was fortunate enough to shoot a specimen (an immature female) at Thornton Reservoir on September 25th, 1884. The Rev. Churchill Babington states that it has been killed at Groby by the keeper of the Earl of Stamford (see Potter's 'History of Charnwood Forest').

Eudromias morinellus (Linn). Dotterel.—Formerly occurring in the county as a spring and autumn migrant. The Rev. Churchill Babington states that five were brought down at a shot by Mr. Tomlinson, jun., at Charnwood Heath, and that Miss Watkinson, of Woodhouse, had one, taken near Buddon Wood." Sir George Beaumont possesses a specimen killed near Coleorton, and Mr. Potter, of Billesdon, reports two shot at Ilston, by Mr. J. Allen, of Frisby Lodge.

Vanellus vulgaris (Bechstein). Lapwing.—Resident, generally distributed and breeding. In winter it is often met with in large flocks. Mr. Davenport writes:—"In April, 1884, I remarked a cock and two hen Lapwings frequenting a ploughed field for some little time; eventually I found the two nests on the same morning, within ten yards of each other, each nest containing four fresh eggs. I am sure there was only one male bird with the two hens. On November 4th, 1885, Lapwings were reported to be flocking in meadows by the Aylestone-road Gas Works, and the next day—the floods being 'out'—I saw several flocks of some six or seven hundred or more congregated in meadows opposite the Aylestone-road Mill."

Strepsilas interpres (Linn.). Turnstone.—An accidental visitant. Turner received a male and female shot at the Abbey Meadow four or five years ago, and I saw a young one on Feb. 2nd, 1884, which had been shot in the Abbey Meadow in the spring of 1883; also an old one shot at the same time and place.

Hæmatopus ostralegus, Linn. Oystercatcher.—A rare and accidental visitor. Harley states that one occurred at Loughborough in the year 1840, and Mr. G. H. Finch, M.P., of Burley-on-the-Hill, Oakham, Rutland, informs me that one was killed there by his keeper some years since.

Family Scolopacidæ.

Recurvirostra avocetta, Linn. Avocet.—Mr. Wolley, of Beeston, saw a specimen of this rare visitor while fishing near the confluence of the Soar with the Trent in June, 1856 (see 'Zoologist,' 1856, p. 5280). It passed over his head, giving a distinct view of its upturned bill.

Phalaropus fulicarius (Linn). Grey Phalarope.—Of uncertain occurrence. Harley states that during the autumn of 1841 and the following winter several were captured throughout the county. The species occurred again in the autumn of 1846, and also in Dec., 1853, when a fine specimen was shot by Mr. Bloxam, of Twycross. Moreover, towards the close of 1854 it appeared at Foxton, where one was shot on the canal which passes through that village. Another, killed by Rev. H. Matthews, at Foxton, in the winter of 1860, is now in the possession of the Rev. A. Matthews.

Scolopax rusticula, Linn. Woodcock.—A winter migrant, not very common; occasionally remaining to breed in Martenshaw, and also in the woods at Donnington Park in the northern division of the county, at Coleorton and in Owston Wood. Mr. Davenport shot a very light-coloured variety in Cold Overton Wood in Dec., 1883.

Gallinago major (Gmelin). Great Snipe; Solitary Snipe; Double Snipe.—A rare winter visitant. According to Harley, Mr. Chaplin, of Groby, shot one in Martenshaw Wood during the winter of 1838. Another was killed near Lutterworth some years ago by Mr. Sansome, of that town. A third was obtained at Noseley a few years since, and a fourth in 1879, near Smeeton, by Mr. Elliott. Last winter one was picked up dead at Billesdon, and has been preserved. It appeared to have died from want, as it was quite uninjured. The late Mr. Widdowson's diary contains a record of one killed at Little Dalby on Sept. 28th, 1868. On September 2nd, 1885, Mr. A. Ross, of Leicester, whilst shooting over the Garthorpe Estate, near Melton Mowbray, killed a Great or "Solitary" Snipe, which his dog pointed in a clover field, and, as is usual with this species, at some considerable distance from water. The specimen, a fine dark-plumaged one, weighing nearly 8 oz., was presented by Mr. Ross to the Leicester Museum. This was recorded in 'The Field' for Sept. 12, 1885. I saw, in the possession of a man named Ludlam, a Great Snipe which had been shot by Mr. J. C. A. Richards, in a field at Blaby, during the first week in September, 1885. Mr. G. H. Finch, M.P., of Burley-on-the-Hill, Oakham, Rutland, reports that a specimen was shot in his neighbourhood.

Gallinago cœlestis (Frenzel). Common Snipe; Full Snipe.—Generally distributed, but not so common as formerly.

Limnocryptes gallinula (Linn). Jack Snipe; Half Snipe.—A winter visitant, generally distributed, but not very common.

Tringa alpina, Linn. Dunlin; Stint.—An uncommon spring and autumn visitant. Specimens have been obtained at Bosworth, Loughborough, and Saddington Reservoir. Mr. S. Bevans showed me four mounted specimens which were shot by him in the Abbey Meadow seven or eight years ago, and I purchased one which was said also to have been killed in the Abbey Meadow some years ago. Two others, which I saw in the flesh in winter plumage, were shot at Fleckney by Mr. C. Allsop on Oct. 20th, 1885.

Tringa minuta (Leisler). Little Stint.—Two of these rare little waders were shot out of a party of five on September 22nd, 1885, at Saddington Reservoir, by my friend Mr. Macaulay, who generously presented them to the Leicester Museum. The largest of the two, an immature female, containing small eggs, weighed 352 grs.; total length, 6¼ inches; bill, 8-10ths of an inch; tarsus, 17-20ths of an inch; carpus to tip of wing, 4⅛ inches. The other, also apparently an immature female, but rather difficult to determine, weighed ¾ oz. or 330 grs.; extreme length (tip of bill to end of tail), 5⅞ inches; bill, 8-10ths of an inch; tarsus, 8-10ths of an inch; carpus to tip of wing, 4 inches. The occurrence of these was noted in the 'Field' of October 10th, 1885.

Tringa temmincki (Leisler). Temminck's Stint.—Macaulay records (Mid. Nat., 1882, p. 78), that a specimen of this bird was shot at Saddington Reservoir by Rev. H. Marriott, in March, 1860. It was seen and identified by Rev. A. Matthews, of Gumley.

Tringa subarquata (Güldenst). Curlew Sandpiper.—Harley writes:—"The appearance of this species of *Tringa* in the county, I am enabled to record on the testimony of a sportsman resident at Loughborough, who shot one on the banks of the Soar."

Calidris arenaria (Linn.). Sanderling.—Some years since, according to Harley, who examined them, three or four birds of this species were shot near the Reservoir in Charnwood Forest.

Tringoides hypoleucus (Linn.). Common Sandpiper.—A summer visitor. Potter, in his 'History of Charnwood Forest,' mentions Gracedieu and Groby Pool as localities for it. Harley says it bred on the banks of Groby Pool, as he learned from Mr. Chaplin, who found it there. Mr. Macaulay states that it breeds at Saddington Reservoir, but his only ground for this assertion is the fact of his having seen immature birds there during late summer. Mr. Bevans reports it as commonly occurring years ago in spring in the Abbey Meadow. I have received specimens from Saddington and Thornton Reservoirs, Wistow, Belgrave, and Aylestone. One which we shot at the latter place was merely wounded, and thereupon swam and dived with ease. It remains with us from the middle of April to the middle of September in ordinary seasons.

Helodromas ochropus (Linn.). Green Sandpiper.—A spring and autumn visitor, remaining sometimes during the winter. It has been noticed on the Soar and Trent, at Groby Pool, the Wreke, Smeeton Brook, and Saddington Reservoir. A mounted specimen was presented to the Town Museum on April 7th, 1851, by Mr. Job Glover, "killed in Leicestershire," presumably at Bagworth.

Totanus glareola (Gmelin). Wood Sandpiper.—Harley characterises this species as more rare and shy than its congener *H. ochropus*. It was met with during the winter of 1852-3, and it occurred also at Groby Pool in 1840.

Totanus fuscus (Linn.). Spotted Redshank.—One in the collection of Mr. J. Whitaker, of Rainworth, Notts, is said to have been shot at Thornton Reservoir in September, 1880.

Totanus canescens (Gmelin). Greenshank.—Has been shot on the banks of Groby Pool, and also at Swithland. Yarrell, on the authority of a resident at Melton Mowbray, stated that it is not uncommon in the more eastern parts of the county. I saw a specimen in the possession of Dr. Elkington shot at Enderby in September, 1885.

Limosa lapponica (Linn.). Bar-tailed Godwit.—Potter, in his 'History of Charnwood Forest,' says, "One in winter plumage was shot in the meadows near Swarkestone, and is preserved at Coleorton Hall, the seat of Sir G. Beaumont, Bart."

Limosa ægocephala (Linn.). Black-tailed Godwit.—On the authority of Mr. Evans, of Market Bosworth, Harley recorded a specimen shot in the vicinity of Market Bosworth, and a second at Osbaston. There is a specimen in the Leicester Museum in summer plumage marked "Leicestershire, 1869."

Numenius phæopus (Linn.). Whimbrel.—The Rev. Churchill Babington's "List of Birds," in Potter's 'History of Charnwood,' includes a specimen of this bird shot near Charnwood Heath. Harley says "it occurs occasionally in small numbers, in the meadows about Loughborough, at Bosworth, and elsewhere in the county. One was killed near Leicester, April 23rd, 1856."

Numenius arquata (Linn.) Curlew.—According to the Rev. Churchill Babington, one shot at Benscliff is preserved at Rothley Temple. Harley states that before the Forest of Charnwood was enclosed the Curlew was plentiful there. The MS. Donation Book of the Leicester Town Museum records the gift, on October 2nd, 1865, by Mr. H. B. Chamberlain, of a Curlew shot at Desford.

(To be continued.)

NOTES AND QUERIES.

MAMMALIA.

White Fox in Somersetshire.—The specimen recorded by Mr. Cecil Smith (p. 104), as taken on Mr. Esdaile's property on the Quantock Hills, is not the first that has been seen in Somersetshire. About six years ago one of the best sportsmen in the county, whilst hunting with the Stag-hounds at Haddon, saw a White Fox in those woodlands. It had been disturbed by the tufters, and came along the pathway till within ten yards. Mr. Esdaile's specimen has been admirably set up by Mr. Rowland Ward, and is now on view in his window in Piccadilly.—James Turner (27, De Vere Gardens, Kensington).

Variety of the Mole.—An orange-coloured variety of the Mole was killed during the first week of May in the immediate vicinity of Oxford.—Arthur H. Macpherson (51, Gloucester Place, Hyde Park, W.).

Black Variety of the Short-tailed Field Mouse.—On June 25th a black variety of the Short-tailed Field Vole, *Arvicola agrestis*, was killed in a clover-field in this parish by some haymakers. It was a female suckling young ones, all of which were, according to the men, of the normal colour. The fur of this specimen is thick and abundant, and is of a rich shining black above, the under parts being just a shade lighter. This species seems to be rather subject to variation, the capture of white and cream-coloured examples having several times been recorded. Lord Clermont, in his 'Quadrupeds and Reptiles of Europe,' also mentions the occurrence of both black speckled individuals, but I believe these last to be more rarely met with.—G. T. Rope (Blaxhall, Suffolk).

BIRDS.

Redshanks and Lapwings breeding in Chatham Dockyard.—These birds breed quite commonly in many of the grassy meadows on the banks of the Medway, between Chatham and Sheerness; but I dare say it will surprise many of your readers to hear that they breed in Her Majesty's Dockyard at Chatham. Nevertheless such is the fact. Upon our arrival at Chatham, early in May, I was told that there were several pairs of Plovers breeding upon a piece of waste ground between the large basins and the sea-wall, but as I could scarcely credit it I did not go to see until I heard the statement repeated; and then, accompanied by one of my messmates, who had already seen the nests, I visited the spot on the 11th of May. The piece of ground is about thirty acres in extent, covered with rough grass, and has one or two small muddy pools in it. It is in the form of a triangle, being bounded on one side by the river, on another by two large basins, and on the third side partly by small garden plots in the occupation of dockyard officials and partly by the extension works, where large numbers of convicts are daily employed. At every hundred yards or so by the sea-wall there is a sentry-box, where one of the prison warders keeps walking to and fro upon a raised platform all the time the convicts are at work. To get to these boxes these men have to cross this ground several times during the day. Besides this, H.M.S. 'Pembroke,' the admiral's flagship, lies in one of the basins not more than three hundred yards off, and the ground is being constantly used by the blue-jackets and marines of the ship for foot-ball, cricket, &c. No one would think this a likely breeding-place for such shy birds as Redshanks and Lapwings. However, we had scarcely entered it when we heard the cry of a Lapwing, followed, a moment or two after, by that of a Redshank, and presently several pairs of each rose from the ground and flew round us in their usual excited manner when their breeding-haunts are invaded. After a little search we found two Redshank's and one Lapwing's nests. The former were placed in tufts of grass, and were artfully concealed, the old bird appearing to push the blades of grass well over the nest when she leaves it. The Lapwing's nest was quite exposed upon a patch of bare ground, and contained the full complement of eggs, as did one of the Redshank's, while the other had three eggs. There were three or four pairs of Lapwings, and six or seven pairs of Redshanks. Besides the nests with eggs there were several depressions in other tufts of grass, where nests had evidently been commenced. A few days later the nest containing three eggs had its full complement; and another nest, also with full complement of eggs, was found. In addition to these birds I noticed large numbers of Skylarks and Titlarks, a few pairs of Common Buntings and Yellow Wagtails, and one pair of Whinchats breeding in Chatham Yard. In the neighbourhood of Harwich, during the first week in June, I noticed Redshanks and Lapwings breeding in several localities; and on June 8th, on the shingle, near Felixstowe, there were a number of Ringed Plovers and a colony of Little Terns breeding. The latter had young, as most of the old birds were carrying small fish; but I could find neither eggs nor young. The same day, while looking for larvæ of *Bombyx castrensis*, in a marshy field on the banks of the Stour, I nearly trod upon a young Lapwing as it was crouching in a tuft of grass; and a little farther on I found another. They were almost fully fledged, but the wing-feathers were not quite grown. I picked them up and took them to a piece of smooth turfy ground, where I set them down. They ran off at once in different directions; and as soon as they reached high grass they looked about for a convenient tuft and hid themselves. I caught them again and repeated the experiment several times, and always found that they ran off in opposite directions. Had there been four of them I suppose they would all have gone different ways; a wise provision of Nature, for it would not be possible to keep one's eyes on four at once.—GERVASE F. MATHEW (H.M.S. 'Penelope,' Berehaven).

Supposed Occurrence of the Icterine Warbler in Co. Wicklow.— While walking in Coollattin Park Woods on the 29th of May I heard and saw a bird which in every respect corresponded to the description of the Icterine Warbler (*Hypolais icterina*). I was attracted by a splendid bird-song which was quite new to me, and much superior to any that I had heard before, and soon discovered the utterer among the branches of a large oak. I watched the bird for a considerable time, and got a close view, so that it is hardly possible that I was mistaken as to its identity. But for its very superior song, I could hardly have distinguished the bird from our common Willow Warbler, but it was of a more decided yellow colour, and had a longer tail: it was also, like that bird, in continual motion, chasing insects about the branches and frequently darting at them on the wing after the manner of the Flycatcher, pausing now and then to give forth its splendid notes. Often, while hopping among the branches, it would utter some detached twittering notes, but while singing in earnest it would remain perched, swelling its throat and agitating its whole body. The song sometimes began with a few rather harsh strains, but in general it was quite delightful, far surpassing in clearness and melody any other that I have heard. Its notes, heard from the top of the large oak in which it was, were as powerful as the loud strains of the Blackbirds and Thrushes, many of which were singing near, and it seemed wonderful that such sounds could be produced by so small a bird. After watching the bird for about half-an-hour I passed on, but, on returning to the same spot in about an hour's time, I could see or hear no sign of it, nor have I been able since, though I have frequently visited the place. As a specimen of the bird—the only conclusive means of proving such a case—has not been obtained, it is impossible to claim this as an authentic instance of the occurrence of the Icterine Warbler, yet the probable occurrence of so rare a bird is, I think, a matter decidedly worthy of note, especially in Ireland, which is less favoured than England by the presence of the rarer Warblers. As I am well acquainted with the Blackcap, and in some degree with the Wood Warbler, there is no fear of my having mistaken either of these for the bird in question, the power and infinite variety of its notes, as well as the yellow colour, excluding such a possibility. I have been told by the game-keepers that the Common Weasel (*Mustela vulgaris*) is found in Coollattin Park, having been introduced from England among Earl Fitzwilliam's foxhounds. If this be the case a very interesting addition has been made to our Irish mammalian fauna. I will make further inquiries about the matter, and try to obtain a specimen.—Allan Ellison (Shillelagh).

Supposed Occurrence of the Icterine Warbler in Pembrokeshire.—Early in May I heard the notes of a bird which were quite strange to me in our shrubberies. The songster was high up, and concealed in thick foliage, and I did not catch sight of him. Since then a little bird has taken up his station in an ash tree just outside our grounds, by the road-side, at no great distance from where I first heard the unknown warbler. and sings a most delicious song all day long, to the delight of passers by, People who have once heard him return again and again to listen to his melody. The notes are very sweet and liquid, imitating some of the trills of the Song Thrush. Seen high up through the foliage of the ash, he looks like a Chiffchaff, and is very restless while he sings, dancing up and down the branch he may be upon. Occasionally he descends to lower parts of the tree, and then appears to be somewhat darker about the wings than a Chiffchaff; his breast seems of a pale yellow. He has never come close enough to afford me a clear view of his plumage, and I cannot take steps to determine what he may be by shooting so sweet a songster who has been charming us all with his clear and tuneful notes. The other side of his hedge is a swampy cover, a regular jungle of furze, willow bushes, and young spruces, where I have searched several times unsuccessfully for the nest which, no doubt, is there. In my opinion our little warbler is no other than *Hypolais icterina.* My groom, who is a bird fancier, declares that he once heard a little bird singing a similar song in Somersetshire.—Murray A. Mathew (Stone Hall, Wolfscastle, R.S.O., Pembrokeshire).

Ruddy Sheldrake near Limerick.—We have received for preservation a specimen of the Ruddy Sheldrake (*Tadorna rutila*) shot on the River Shannon, at Birdhill, about nine miles from Limerick. It is a female bird, one of a pair shot at the same time by Mr. Swiss, of Birdhill, and bears every appearance of being a wild bird. On making enquiries I am informed that both birds were very shy and difficult to approach. This is the second time that this species has come under our observation, having set up a specimen obtained near Tralee some years ago, which is now in the collection of Mr. J. C. Neligan of that place.—Williams & Son (Dublin).

[The Ruddy Sheldrake is so frequently kept amongst other ornamental water-fowl, and may so easily recover the use of clipped wings after moulting, that it is probable that most, if not all, of the specimens found at large are escaped birds. The fact of their being found in perfect plumage affords no proof of their being truly wild, for birds which have regained their liberty very soon get into good order, and ornamental-water fowl are generally in good condition.—Ed.]

British Examples of the King Duck and Hooded Merganser at Oxford.—In the University Museum at Oxford there are examples of two rare British Birds, of which I can find no mention in the 'Handbook of British Birds' or the last edition of Yarrell's 'British Birds'; it may therefore be worth while to place them on record in the pages of 'The Zoologist.' An adult male King Duck is labelled "Erith Reach, Kent. Presented by Lord Saye and Sele." This specimen formed part of a collection of British birds bequeathed by the late Lord Saye and Sele to the Ashmolean Museum in 1487, and was labelled in that collection "Shot in Erith Reaches, Kent." An old male Hooded Merganser, placed on a stand with two females, has a label at the foot, "Adult male. Bristol, 1845. Rev. S. A. Pears." This bird also came from the Ashmolean Museum (where it was labelled as at present), and it seems that nothing more is known of it. The Rev. Stuart Adolphus Pears was, at the date of the donation, a fellow of Corpus Christi College. To the keeper of the museum I am indebted for these particulars, which have been kindly communicated by Mr. G. A. Rowell, who remarks in reference to the Merganser, "Probably no one now living has the least knowledge on the subject."—Oliver V. Aplin (Great Bourton).

Snow Bunting breeding in Scotland.—The nesting of the Snow Bunting in Scotland is now no longer doubtful, the young having been taken at the nest and the old birds seen within two yards of the observers. Notice will have been given of this at a meeting of the Inverness Field Club by the time this is printed, and a full account of this interesting discovery, as well as a history of the Snow Bunting in Scotland, will appear in a larger work, now in a forward condition of preparation, on the Fauna of Scotland. Materials for this have long been accumulating in our hands.—J. A. Harvie Brown (Dunipace, Larbert).

The Peregrine on the Kentish Coast.—A few weeks ago, while watching the Gulls at Dover, I saw a pair of Peregrine Falcons, and was informed by one of the coastguards that they nest there every year, and commit great havoc among the young Gulls. I was lying on the top of the cliff watching the Gulls below, when I suddenly became aware of a commotion among the birds some distance from me, and on looking in that direction I saw a male Peregrine making repeated stoops at the young Gulls, while the old ones had joined together to drive him away, and in this, after some little time, they succeeded, one fine old Gull following the Peregrine for some distance. I afterwards saw the Falcon making stoops at the Swifts, of which numbers breed in the cliffs; but they were too sharp to be caught. In Yorkshire I know of several regular nesting-places of the Peregrine, but was not aware that it nested annually near Dover.—Riley Fortune (Alston House, Harrogate).

Unusual Site for a Sand Martin's Nest.—On the 20th May I observed a pair of Sand Martins flying up and down in front of my house. Never having seen a Sand Martin in this town before—the nearest colony being distant about two miles—I supposed they had come in to search for food, the weather being cold and wet at the time. I watched them day by day, expecting each day would be the last of their visit, until the 30th May, when, to my surprise, I saw one of the birds gathering material for a nest, and after a short time I saw the hole they had selected. Standing near the outskirts of the town is a stone wall about ten feet high, backed up with earth, in front of which passes a road; along this road is a considerable amount of traffic; any one passing on the footpath would literally brush against the wall. A row of detached houses stands between the wall and the open country. In this wall, about four feet from the ground, the nest was placed, at a distance of about two feet from the entrance. In a very short time the little boys discovered the nest. Owing to their interference the birds appear to have left the town.—William J. Horn (Uppingham).

Edible Birds' Nests.—Permit me to give the result of some observations I made on this subject in the Solomon Islands. It will be remembered that it was the association of these nests with a so-called "fungoid growth" in the caves of North Borneo ('Zoologist,' 1885, p. 43) that led Mr. Pryer to consider that he had found the source of the material of which the nests are made, a supposed discovery which led to the re-opening of the controversy ('Nature,' vol. xxx., p. 271). This low plant-substance was determined by Mr. George Murray to be the result of the growth of a microscopic alga, a species, probably new, of *Glœocapsa* (Proc. Zool. Soc., 1884, p. 532; 'Zoologist,' 1885, p. 147). In the Solomon Islands I was only able to obtain the edible nest in one locality (Oima Atoll), since the bird usually frequents inaccessible sea-caves and cliffs. The nests were of inferior quality, and were for the most part composed of fibrous materials derived from the vegetable drift (the husks of pandanus seeds especially). The gelatinous substance thickly incrusted the interior of the nests and attached them to the rock. The surface of a cliff in the vicinity of the cave frequented by the swifts was coated by a reddish gum-like growth, which proved on examination to be an aggregation of the cells of a protophytic alga about 1-2500 of an inch in size. Unfortunately, my specimens of this growth have miscarried, but I feel assured that it is very similar to that observed by Mr. Pryer in the Borneo caves, samples of which, through the kindness of Mr. George Murray, I had the opportunity of seeing at the British Museum. A similar growth is commonly to be found coating the coral limestone cliffs in this group. It may be seen in all stages, the older portions being dark-coloured and rather tough, and the fresher portions being, as Mr. Pryer aptly remarked, like half-melted gum tragacanth. There are but few cells in the fresh alga, the mass being apparently composed of cellular débris, immersed in a rather diffluent material, the whole somewhat resembling the third section given in Mr. Green's paper ('Nature,' 1886, p. 81). That the salivary glands are especially concerned in the production of the gelatinous nest-substance there can now be but little doubt, and the investigations of Mr. Green have established the nature of its composition; yet it is possible, and I make the suggestion with great diffidence, that a *vegetable mucin*, or a substance closely allied to this animal product, may be found in these low plant-growths.—H. B. GUPPY (95, Albert Street, N.W.)

Habits of the Emu as observed in Confinement.—The breeding habits of the Emu are thus described in a letter to 'Nature' from Mr. Alfred W. Bennett, who had an opportunity of watching the habits of this bird, which was, during several seasons, successfully bred by his father in Surrey. The hen bird, says Mr. Bennett, begins to lay about the end of October or beginning of November, and as each brood consists of twenty eggs or more, laid at intervals of two days, the process takes about six weeks. Before it is completed the cock bird begins to sit. The eggs laid subsequently are deposited by the hen by the side of her mate, who puts out his foot and draws them under him. As soon as the eggs begin to hatch it is necessary to isolate the hen, as she fights furiously with her mate, and would to all appearance kill the chicks if she were allowed to get at them. The whole of the tending of the young is performed by the male bird. This is not the case with the Ostrich, as some have reported.

Hybrids between the Black Grouse and the Pheasant.—In Yarrell's 'British Birds,' 4th ed. vol iii. p. 69 *seq.*, a number of hybrids between the cock Pheasant and the Grey Hen are enumerated as having occurred in England. Being desirous to give a life-sized and coloured figure of such a hybrid in my forthcoming work on the Black Grouse, the Capercailzie, and their allies, I wish to borrow a specimen for a short time, and, as my endeavours to procure one have so far been unsuccessful, I beg to make this known through your widely-read journal, hoping that some fortunate possessor may be kind enough to communicate with me concerning his willingness to lend me a specimen for the said purpose.—A. B. MEYER (Royal Zoological Museum, Dresden, July 5).

Oaks planted by Crows.—Referring to the extract given, at p. 264, from Robinson's 'Natural History of Cumberland,' in which we are told of a grove of oaks of a height for Crows to build in, though but of twenty-five years' growth, and, strange to say, planted by these birds. Although the manner of planting the acorns is described, no attempt is made to account for it. I am therefore induced to refer to what came under my observation respecting Rooks when residing on the north-east coast of Scotland in 1858. I observed that as soon as the Rooks had secured the object of their search (fir-cones), they alighted with them on an open space, and commenced striking and tearing them with their bills; this operation over, they returned to the wood for a fresh supply. Seeing a number of fir-cones strewn about the ground, they were carefully examined, and in some a maggot was found, on which the Rooks were doubtless feeding. It occurred to me at the time, and I noted down, that the stunted firs scattered over the plain might have sprung from cones trodden under foot by cattle, of a wet season, to become in the course of ages nesting-trees for the Rooks, and a shelter for cattle. My observations and remarks with regard to the planting were mere conjectures. That we are indebted to birds for the distribution of various plants, as well as for (to some extent at least) the soil in which they grow, is a well-known fact.—HENRY HADFIELD (Ventnor, Isle of Wight).

Variation in size of the Water Rail.—The Water Rail, like many other birds, has been observed to vary greatly in size, but I do not know that any very great difference in the size of two bones of this species has been remarked upon. The case of two Water Rails has lately come under my notice, in which the sterna vary in such a remarkable degree that it may be worth recording. The following are the measurements:—Keel of sternum, measured along the curve: No. 1, 1·25 in.; No. 2, 1·75 in. Keel, measured in a straight line: No. 1, 1·20 in.; No. 2, 1·65 in. Length of sternum and coracoids: No. 1, 2·05 in.; No. 2, 2·50 in. The smaller sternum I took from a male, procured here in November last, which measured in the flesh 10·3 in. in length; wing, 4·2 in.; bill, from the gape, 1·4 in. I did not obtain the skin of the bird from which the larger bone was taken, but it was an average large-sized example, certainly nothing out of the ordinary way, and apparently about the size of an example shot here in December, 1878, the skin of which measures 11·9 in.; wing, 4·8 in.; bill, from gape, 1·7 in. A male from Sussex, November, 1883, measured in the flesh 12·0 in.; wing, 4·8 in.; bill, from gape, 1·8 in. Although the larger birds are (here at least) much more commonly met with, I have seen several examples of the smaller one lately, and obtained another sternum not any longer than that described here.—Oliver V. Aplin (Great Bourton, Oxon).

Young Rooks with white Chins.—For some years past I have noticed that a considerable number of the young Rooks shot at Rook-shooting time have a small spot of white between the rami of the lower mandible—that is to say, on the chin. This peculiarity is well known to Rook-shooters, but, so far as I am aware, it has hitherto escaped the notice of ornithologists. This spring, therefore, I have been endeavouring to learn what proportion of the birds have the white spot, and whether it is in any way a mark of sex. The area covered by the white feathers varies much in size. For it to be as large as a farthing is exceptional. Often there are only a few stray white feathers. One which I have seen, however, had the spot as large as a halfpenny. The beaks of those birds having the white spot are generally much lighter in colour than the beaks of those without it. Of thirteen young Rooks shot at this place one evening during the third week in May no less than nine had the white spot. Of 111 examined a few days later, in company with Mr. H. L. Wilson, on one of the stalls in Birmingham Market, only forty-one had the spot, while the remaining seventy had not. Of fifty-eight examined on another stall (in all probability from a different rookery) twenty-eight had the spot, while thirty had not. Altogether, therefore, out of 191 birds examined, seventy-eight (or considerably less than one-half) had the white chin spot. We opened three of those with the spot, of which two were females and one a male. Two without the spot proved a male and a female. Clearly, therefore, the presence or absence of the spot is no guide to the sex of a bird. This curious white spot is of interest in connection with the discussion formerly carried on as to the cause of Rooks losing the feathers round the base of the bill, for it should be noted that these white feathers are among those which are lost in the adult bird. The only reference to the white spot which Mr. Wilson or myself have discovered is by Mr. Morris, who, speaking of white and pied varieties, says:—"One I have lately seen—a young bird—had a patch of pure white under the bill, and one or more of the quill-feathers also white.'—R. Miller Christy (Chignal St. James, Chelmsford).

BATRACHIA.

Enemies of the Frog.—When living at Mackay, Queensland, I frequently observed that the common House-frogs, *H. cærulea*, were injured in the hind limbs, and on several occasions I would hear them croaking in pain; but on arrival all I saw would be a wretched exhausted frog weakly hopping away with a wound in the hind leg, from which the blood would be oozing. Later on I found that Rats attack the Frogs. The Rats catch the Frog by the hind leg, and apparently suck the wound they cause, then let the Frog crawl away, attack it and suck it again, and so on until the Rat has had enough. I believe the Rats suck the blood, because I was never able to discover a Frog so attacked on which the flesh had been destroyed. Mr. W. P. Fletcher, a well-known local naturalist, once gave me the following account of a Mantis attacking a Frog. It was in the autumn of 1877, at Rockhampton, Queensland. He was "attracted by hearing the noise of a Frog in distress, in the daytime, in some garden-shrubs about six feet high; he went to see the cause, and found a green Frog about two inches long. A green Mantis about five inches long, with one claw had hold of it across the neck, so that the Frog could not move, and the Mantis was chewing, and did chew off, the hind leg, the blood flowing profusely." He called Mrs. Fletcher to see them, and then destroyed the Mantis, whereon the Frog crawled away. At Lake Elphinstone (100 miles from Mackay) I once found a small Frog, *H. rubella*, in the house in a very exhausted condition; on examination I found a large Leech on its tongue. This specimen, with the Leech attached, I gave to Mr. Boulenger at the British Museum, where it can be seen. At Mackay the chief enemies of the Frogs appeared to be the Snakes and the *Agamidæ*.—H. Ling Roth (48, Wimpole St., W.).

REPTILES.

Viper swallowing its Young.—The attention of a woodman in my employ, who was trimming the sides of a neighbouring wood, was attracted by a hissing noise at his feet; on looking down he saw a large Viper lying distended in a cart-rut in the act of receiving five young Vipers into its mouth, which he distinctly saw the reptile open wide before the first of the five crawled in. It was immediately dispatched, and on cutting the body open the woodman found the young ones alive and wriggling some distance down, and still further towards the posterior end an entirely uninjured and undigested Shrew-mouse. This is one of the most authentic corroborations of the vexed question whether or not the Viper receives its young into its mouth when in danger.—J. C. Mansel-Pleydell (Whatcombe, Blandford).

FISHES.

Opah or King Fish in Shetland.—An Opah, or King-fish, *Zeus luna*. which is exceedingly rare, was recently caught off the Shetland Islands, and brought to the Colonial and Indian Exhibition for inspection. The specimen, which is in perfect condition, measures about five feet in length, and weighs 160 pounds. The colours of the sides and back are dark green intermingled with gold and purple, while the irides are red. The Opah possesses peculiar migratory propensities, being found even in Eastern seas. Its habits seem to be little known, but Mr. W. August Carter, of the Colonial and Indian Exhibition, states that, according to inquiries and investigations he has made, the Opah varies its diet according to the locality it inhabits, and that when visiting the British Islands it feeds chiefly upon herrings and cuttle-fish.—*Nature*.

MOLLUSCA.

Arion subfuscus and Helix hispida var. fusca in Yorkshire.—On June 2nd I found three specimens of *Arion subfuscus*, Drap., in a garden at Lofthouse. The species is well marked, being of an orange-brown colour, the shield somewhat brighter and clearer than the other parts. It is larger than *A. hortensis*, and it is surprising that the species has been so long overlooked. As it is apparently not rare, it must have been taken for a yellow variety of *A. hortensis*. I sent the three specimens to Mr. Cockerell, of Chiswick, who identified them for me. Together with a few other slugs and shells I sent a few specimens of *Helix hispida*, which Mr. Cockerell states are Mencke's variety *fusca*, well known on the Continent, but which does not appear to have been previously recognised in the British Isles.—GEORGE ROBERTS (Lofthouse, Wakefield).

Limax arborum and the influence of altitude on Colour.—It has been observed that in this species, as in some others, individuals found in cold regions, or at great altitudes, are invariably darker, and have their markings more suffused than those of the warmer or less elevated regions. Two very striking instances of this have recently come under my notice, and seem to me to deserve recording. The Rev. A. H. Delap, sending me slugs from the neighbourhood of Clonmel, Ireland, has included specimens of *L. arborum* from the plains of North Waterford, which are distinctly and beautifully spotted with black, where he says they are locally abundant, and the ordinary form of England and Scotland had not been met with. But one day he ascended the Reeks (in Waterford), and a hundred feet from the summit he met with the English type of the species; and at the extreme summit, 2300 feet above the sea-level, he found examples of a grey-black form in which the markings were entirely suffused over the body and rendered invisible. This is the more interesting, because in the plains of Italy the type-form is prevalent, but, just as in Waterford, the dark variety is only found high up on the mountains, ascending to nearly 8200 feet. The other instance is that of *L. maximus* in the South of England. Mr. J. H. James has carefully searched Truro for varieties of this slug, and it is remarkable that all he has found there were distinctly spotted or striped with black or dark grey. These forms, so common in Cornwall, are either rare or absent in the colder Thames Valley, all our examples being dull and ill-marked, the almost unicoloured variety prevailing. Similarly, in the case of *Arion ater*, the variety in which the colours are distinct and well-defined, occurs at Truro, near Clonmel, and in various other localities in the south-west, but seems to be entirely absent in the Thames Valley.—T. D. A. Cockerell (Bedford Park, Chiswick).

SCIENTIFIC SOCIETIES.

Zoological Society of London.

June 29, 1886.—Osbert Salvin, Esq., F.R.S., Vice-President, in the chair.

The Secretary exhibited, on behalf of Mr. John Brazier, of Sydney, New South Wales, a series of eggs of the Pacific Porphyrio, *Porphyrio vitiensis;* and read a note showing the extraordinary fecundity of an individual of this species, which had laid in seven years 491 eggs.

The Secretary read a letter addressed to him by Capt. Vipan, giving particulars of the nesting of a South-American Siluroid Fish, *Callichthys littoralis,* in his aquarium.

A communication was read from Mr. Gilbert C. Bourne, containing general observations on the fauna of Diego Garcia, the southernmost island of the Chagos Group, situated in the centre of the Indian Ocean.

Mr. Howard Saunders read a paper containing a description of the collection of birds obtained by Mr. Gilbert C. Bourne on the island of Diego Garcia. The species represented in the collection were stated to be fourteen in number, of which one only was a land-bird (introduced), the remainder being oceanic birds or migrants of wide distribution.

Mr. J. Bland Sutton read a paper on the intervertebral disk between the odontoid process and the centrum of the axis in man.

Prof. R. Ramsay Wright gave an account of *Sphyranura Osleri,* a recently-discovered ectoparasitic Trematode, intermediate between *Gyrodactylus* and *Palystomum,* which infests the gills and skin of *Menobranchus.*

A communication was read from Mr. Gervase F. Mathew, R.N., containing descriptions of a new genus and some new species of Rhopalocera which he had obtained during a recent visit to the Solomon Islands.

Mr. R. Bowdler Sharpe read a paper containing an account of a collection of birds from Perak, which contained examples of several forms hitherto only known from Sumatra.

A second paper by Mr. Sharpe continued the series of his notes on the specimens in the Hume Collection of Birds in the British Museum. The present communication treated of some of the Rose Finches, of *Lalage melanothorax*, and of some Flycatchers of the genus *Siphia*.

Mr. Arthur G. Butler read a paper on a series of Lepidoptera collected by Major Yerbury at Campbellpore, Western India. The collection contained examples of 177 species, many of them represented by a fair series of specimens. Six of the Butterflies and nineteen of the Moths were described as new.

Mr. Sclater read a list of a collection of birds obtained by Mr. H. Berkeley James from the province of Tarapacà, Northern Chili. The collection contained 147 skins, referable to 52 species, amongst which was a new three-toed Flamingo of special interest, which was proposed to be called *Phœnicopterus Jamesi.*

Mr. A. Smith Woodward read a note on the presence of a columella (epipterygoid) in the skull of Ichthyosaurus.

Mr. Herbert Druce read a paper containing the description of some new species of Heterocera from Tropical Africa.

Mr. Boulenger read a report on the additions made to the Batrachian Collection in the Natural History Museum since the publication of his catalogue. To the report were added descriptions of some new species, the most interesting of which was a new Newt, *Geomolge Fischeri,* from the Ussuri River, Mantchuria.

This meeting closes the present session. The next session (1886–87) will commence in November next.—P. L. SCLATER.

ENTOMOLOGICAL SOCIETY OF LONDON.

July 7, 1886.—J. JENNER WEIR, Esq., F.L.S., Vice-President, in the chair.

Mr. S. H. Scudder, of Cambridge, Mass., United States, was elected a Foreign Member of the Society.

The Rev. H. S. Gorham exhibited specimens of *Eucnemis capucina* (Ahr.), a species new to Britain, discovered in June last in an old beech tree in the New Forest. He also exhibited specimens of *Cassida chloris.*

Dr. Sharp exhibited larvæ of *Meloë,* and read notes on their habits; and Mr. Saunders exhibited a specimen of *Halictus* infested with about thirty *Meloë* larvæ.

Mr. Billups remarked that he had recently found forty-seven larvæ of *Meloë* on the body of a specimen of *Eucera longicornis.*

Dr. Sharp said that he was of opinion that the operations of these larvæ were not the result of instinct, but were more like reflex actions; the instant the larvæ touched a suitable surface they clung to it. The discussion was continued by Prof. Riley, who disagreed with Dr. Sharp, and believed these larvæ were guided by instinct, as they showed a decided preference for particular hosts.

Mr. Jenner Weir exhibited a male of *Lycæna bellargus* and a female of *L. icarus*, which had been captured *in copulâ* by Mr. Hillman, and shown to the exhibitor at the time of capture. Mr. Weir also exhibited some specimens of *Lycæna* which he believed to be hybrids between *Lycæna bellargus* and *L. icarus;* and he further exhibited, on behalf of Mr. Jenner, four specimens of *Phosphænus hemipterus*, taken at Lewes.

The Rev. W. W. Fowler exhibited two specimens of *Chrysomela cerealis*, lately taken by Dr. Ellis on Snowdon; and also two specimens of *Actocharis Readingii*, found at Falmouth by Mr. J. J. Walker.

Mr. E. B. Poulton called attention to the fact that the larvæ of some Lepidoptera, if fed in captivity on an unusual food-plant, subsequently refused to eat their ordinary food-plant. He stated that he had observed this with the larvæ of *Pygæra bucephala* and *Smerinthus ocellatus*. Mr. Stainton, Mr. Fowler, and others made some remarks on the subject.

Mr. Elisha exhibited a series of bred specimens of *Geometra smaragdaria*, together with the cocoons, containing the empty pupa-cases, attached to the stems of the food-plant.

Mons. Alfred Wailly, who was present as a visitor, exhibited a long series of silk-producing moths, including some remarkable hybrids between *P. cecropia* and *P. ceanothi;* and Professor Riley and Mr. Weir made some observations on these hybrids.

Dr. Sharp read a paper on "*Eucnemis capucina* (Ahr.) and its larva."

Mr. Dunning read a report on the subject of the importation of hnmble-bees into New Zealand, from which it appeared that the efforts of Mr. Nottidge, of Ashford, and the Canterbury (N. Z.) Acclimatisation Society, had been successful, and that the long-wanted clover-fertiliser had at length been established in New Zealand.

Mons. Peringuey communicated "Notes on some Coleopterous Insects of the family *Paussidæ*."

Mr. J. B. Bridgman communicated "Additions to the Rev. T. A. Marshall's Catalogue of British Ichneumonidæ."

Prof. Riley read "Notes on the phytophagic habit, and on alternation of generation, in the genus *Isosoma*." In this paper Prof. Riley described, from direct observation, the phytophagic habit in two species of the genus. —HERBERT GOSS, *Secretary*.

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